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ABSTRACT

The use of a longitudinal database to study the impact of a variety of student programs on student success is discussed. This study addresses the question of which programs and groups of programs most strongly influence student success. Programs designed to help engineering students at eight colleges are studied in order to determine the factors that significantly contribute to student success. Types of programs in this study include mentoring programs, summer residential programs, and engineering orientation programs. Student success is measured by graduation rates, grade point averages, and time-to-graduation. Although the primary study is still a work in progress, its potential to be a landmark study of this type makes it desirable to discuss the research study at its present stage. A longitudinal database under continuing development by the National Science Foundation-sponsored by Southeastern University and College Coalition for Engineering Education (SUCCEED) is used in this study. The database covers all entering cohorts from 1987 to the present. The longitudinal database is particularly useful for establishing control groups from the general population of engineering students, since data from all eight engineering colleges are placed in a common format. (Contains 34 references.) (Author/SAH)

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Studying the Contribution of Programs at Eight Engineering Colleges toward Student Success

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Abstract: The use of a longitudinal database to study the impact of a variety of student programs on student success will be discussed. This study addresses the question of which programs and groups of programs most strongly influence student success. Programs designed to help engineering students at eight colleges are being studied in order to determine the factors that significantly contribute to student success. Types of programs being included in this study are mentoring programs, summer residential programs, engineering orientation programs, and others. Student success will be measured by graduation rates, grade point averages, and time-to-graduation. Although the primary study is still a work in progress, its potential to be a landmark study of this type make it desirable to discuss the research study at its present stage.

A longitudinal database under continuing development by the NSF-sponsored Southeastern University and College Coalition for Engineering Education (SUCCEED) will be used in this study. The database covers all entering cohorts from 1987 to the present. The longitudinal database is particularly useful for establishing control groups from the general population of engineering students, since data from all eight engineering colleges have been placed in a common format.

This work is sponsored by an NSF Postdoctoral Fellowship for Science, Mathematics, Engineering, and Technology Education (PFSMETE) award. This paper will address the classification of programs into a smaller number of independent variables that will allow comprehensive programs to be broken down and their components analyzed separately. The approach to data collection and the statistical methods that will be used to quantify the relative benefit of different types of programs will also be discussed. The presentation of this paper will be interactive, as feedback from those attending the session will have an opportunity to affect the course of the study at this early stage.

Keywords: longitudinal, assessment, success, retention, evaluation

1 Introduction

Chickering and Reisser (1993) identify friendships and student communities and student development programs and services as key influences on student development. Astin illustrates a wide variety of effects of different types of student involvement (1993b). Tinto notes that effective retention programs are due to extra-curricular programs as much as or more than what occurs within the classroom (TINTO, 1987). Longitudinal studies by the Higher Education Research Institute and a wide variety of other sources have indicated that participation by students in various types of extra-curricular activities has a positive influence on student persistence and success in their academic programs. (ASTIN and SAX, 1998, ASTIN, 1993a, 1993b, and 1984, MALLETTE and CABRERA, 1991, NORA, 1987, PASCARELLA and TERENZINI, 1991 and 1980, TERENZINI and PASCARELLA, 1977, PARKER and SCHMIDT, 1982, ORY and BRASKAMP, 1998, TINTO, 1998 and 1997, and DEY, 1997)

This work, sponsored by an NSF Postdoctoral Fellowship for Science, Mathematics, Engineering, and Technology Education (PFSMETE) award, is proposed to extend what was learned in these and other longitudinal studies. The motivation to collect information on student programs will be discussed, followed by a description of the SUCCEED longitudinal database, which will be used in this study. If a broad and sufficiently comprehensive set of programs that help students to be successful can be identified, a set of predictors can be identified through factor analysis (BORG and GALL, 1989, 628). A typical set of programs already identified will then be reviewed. In order to reduce the number of independent variables in the study, all programs included in the study will be broken down into components. The components that have already been identified for classification will be discussed, although this set is still in a state of flux, as more programs are added to the set under consideration. By observing the variance associated with various program components, the strength of the contribution of those components to student success will be approximated. Finally, the statistical approach to analysis of the program components will be included.

2 Motivation to Collect Information on Student Programs

This type of research is best performed through a longitudinal study (BORG and GALL, 1989, p. 421, and ASTIN, 1991). The longitudinal database under development by the SUCCEED, described further below, indisputably contains a vast amount of data describing which students have succeeded in the pursuit of engineering majors and which have not. What the data alone do not tell us is *why* some students succeed and some do not. Universities and their Colleges of Engineering offer a wide range of programs that are intended to positively influence student success. This study addresses the question of which program components most strongly influence student success. Types of programs being included in this study are mentoring programs, tutoring programs, summer residential programs, and engineering orientation programs. Other criteria affecting program inclusion are discussed later. Student success may be measured by persistence (retention), graduation rates, grade point averages, and time-to-graduation.

College and University personnel implementing student programs must answer questions such as, "Does this program help students?" or "Does this program help students better than the program we used to use?" While the database used in this study can address these questions, this research plan intends to address the broader question, "Which program components and groups of program components most strongly influence student success?" Earlier longitudinal studies have studied the effects of participation in service activities and other student programs on student success. The approach to identifying such student participation has always been through survey instruments, because it has always been too intensive to collect information directly from those that conduct student programs. The support of the NSF PFSMETE postdoctoral fellowship and the benefits of the SUCCEED partnership are helping to simplify the difficult task of collecting this kind of information. The additional benefit of this more comprehensive approach is that, using information about the types of programs students participate in, different approaches to improving student success can be weighed against one another in the context of determining how to most effectively help our students. The focus of this work on the success of engineering students allows the constraint of the programs under study. Since engineering majors are students, any programs open to all students are considered. Programs sponsored by the Colleges of Engineering are added to learn about the more comprehensive set of programs available to engineering students. The much broader set of programs offered to students in other majors by colleges outside the College of Engineering is not considered.

3 The SUCCEED Longitudinal Database

A longitudinal database is under continuing development by the NSF-sponsored Southeastern University and College Coalition for Engineering Education (SUCCEED). The database contains data for all entering cohorts from 1987 to the present at SUCCEED member institutions. SUCCEED's members include the headquarters at the University of Florida (UF) and the other member institutions: Clemson University, Florida A&M University (FAMU), Florida State University (FSU), Georgia Institute of Technology (Ga Tech), North Carolina A&T State University (NC A&T), North Carolina State University (NCSU), University of North Carolina at Charlotte (UNCC), and Virginia Polytechnic Institute and State University (Va Tech). These nine institutions contain eight engineering colleges, since FAMU and FSU have a joint College of Engineering. The longitudinal database is particularly useful for establishing control groups from the general population of engineering students, since data from all eight engineering colleges have been placed in a common format.

Data are collected in a variety of formats from the nine SUCCEED institutions. A description of each institution's data definitions tempered with knowledge of the different academic policies allows merging of a common set of data in a consistent format. The SUCCEED longitudinal database has three components: 1) a demographic component, which contains unchanging data such as ethnicity, gender, matriculation date, matriculation major code, high school GPA, SAT scores, and ACT scores; 2) a term component, which contains data that change each term including term and cumulative GPA, major field of study, and course load; and 3) a graduation component, which contains records for each bachelor's degree awarded to each student in the database. A common identifier, the student's social security number, synchronizes records in each of the components of the database. The SUCCEED longitudinal database only includes records for undergraduate, degree-seeking students. A more complete description of the SUCCEED longitudinal database is available elsewhere (CARSON, 1997).

Another benefit of using the SUCCEED longitudinal database for this study is that it will continue to be augmented. All SUCCEED schools have made a commitment to provide supplementary data each year continuing until five years after the end of the current SUCCEED Cooperative Agreement in 2002.

4 Criteria for Consideration in this Study

As discussed earlier, this study is limited to programs either offered by Colleges of Engineering or by the Universities. Therefore, one criterion for inclusion is that a program either serves engineering majors specifically or all students generally. Since the SUCCEED longitudinal database only contains data for undergraduate, degree-seeking students, we can eliminate any programs that by their nature do not serve that population: recruitment and outreach programs, graduate programs, and continuing education programs aimed specifically at non-traditional students. Since the SUCCEED longitudinal database only has cohorts since 1987, programs that do not have data for those cohorts are not of interest for this study.

Another consideration is that programs included in this study will generally be those programs that affect some sub-group of the population rather than the population as a whole. For example, all the institutions in this study have some form of orientation during the summer prior to first-time-in-college matriculation. Since all (or very nearly all) students attend these orientation sessions at their respective institutions, the orientation program becomes an integral part of the character of the institution. Measuring differences in the effects of different orientation programs will be severely confounded by other factors including the different populations that enroll at each institution and any differences in academic policies and record-keeping. This is because there is no control group of students at the same institution that have not participated in those programs. All the orientation programs will, however, be characterized to be sure that none is drastically different from the rest. Although the effects of curricular changes over time will be difficult to identify, when major revisions of special introductory engineering courses occur, they will be noted. This information will be of particular interest if any sustained improvements can be identified that were concomitant with the inception of the curricular change.

Some programs will be identified but not included in the study, because individual data are not available. In such cases, aggregate data of student participation will be obtained where possible in order to be aware of the impact on the study of the missing data. A number of programs have already been identified for which data have been kept, but are confidential. The creation of the SUCCEED longitudinal database and studies resulting from it have been permitted on the basis of conducting educational research, one of the premises under which confidential student information may be given out. Unfortunately, programs of a counseling nature cannot be released under this exception. For example, the Thomas E. Cook Counseling Center at Virginia Tech offers a variety of success skills courses—and it would benefit the present study to follow the students who have taken those courses. Students who come to the Cook Counseling Center, however, do so with the understanding that their attendance in any events at the Counseling Center are considered confidential, similar to any other visit with a counselor (Amenkhienan, 1998). This confidentiality is covered by different regulations and cannot be violated for the purposes of educational research.

5 Student Program Identification

The broad scope of this study precludes finding all possible programs in a single pass. Those aware of any student programs at NC State that are not mentioned here are asked to contact the authors. Typically, there is no one source to identify all available student resources at an institution. As a result, a wide range of sources will be used:

- Searching University World-Wide Web pages
- Campus visits to speak with student program personnel
- Secondary contacts recommended during meetings on first campus visit
- Student handbooks
- Campus phone directories
- Undergraduate course catalogs (student resources are frequently identified in such books)
- Responses from those who read the lists here and recommend additions to the authors
- Additions from those who read similar lists sent to personnel at each institution

To date, campus visits have not been conducted at all the SUCCEED member institutions. Specifically, Clemson, Georgia Tech, NC A&T, NC State, and Virginia Tech have been visited. The number of additional contacts identified during the first visit to each campus clearly show that another visit is indicated. Nevertheless, any programs that the reader might suggest for inclusion in this study are welcome.

6 Example: Programs at North Carolina State University

First-Year Engineering Curriculum Revision: A wide variety of research into first-year engineering courses has been performed at NCSU in the first five years of SUCCEED (FELDER et al., 1997, BEAUDOIN et al., 1995, ZOROWSKI, 1996, SUTTON et al., 1995, PORTER and FULLER, 1998). The students in the experimental course cohorts will be identified, but are generally small in number when compared to the larger cohort of freshmen engineers. In preparation for the Fall 1998 semester, a group of these freshman-year innovators and teachers gathered and discussed the characteristics desired in a freshman course and studied the coverage of those characteristics by the various approaches taken (PORTER, 1998). This new course is being offered to a much larger cohort of 1100 first-year engineering students (PORTER et al., 1999, OLLIS et al., 1999, and YARBROUGH et al., 1999). While not included specifically in the study of student programs analyzed by components, this significant curriculum revision will be considered for its potential to change the baseline for student success.

The First Year College (CONWAY, 1998) is a special program for students who have not yet decided on a major at NC State. In reality, this includes three populations—those who are truly undecided, those considering engineering but are hedging against the possibility of not being accepted for admission into the College of Engineering, and a third group who have already been refused admission to the College of Engineering. The third population of these will not be admitted to the First Year College starting in Fall 1999. Admission to the First Year College has been subject to an academic index cutoff of 2.5 from 1995-1998 (admission below the cutoff is subject to special review), and may be raised for the 1999-2000 academic year. The First Year College includes a variety of features:

- Weekly advising by professional advisors

- A special course on topics of special interest to first year students
- Scheduling of classes with others in the program
- Faculty and peer mentoring and tutoring
- Special residence halls for program participants

The Academic Enrichment Center (STONEHOUSE, 1998) is a tutoring center that was opened by the First Year College in Fall 1997. The Center was first open only open to those in the First Year College and/or the Renewed Commitment Program (described below), but in Fall 1998, it opened to all students. The center keeps track of the students who come to meet with its paid undergraduate mentors who are trained for the job.

The Renewed Commitment Program (RCP) (STONEHOUSE, 1998) addresses the special needs of students placed on academic warning (GPA below 2.0). RCP includes reflection groups that meet one hour per week in small groups with RCP staff members, individual meetings with reflection group leaders, and at least one visit to the Academic Enrichment Center per week. The program is voluntary, but requires a signed commitment to participate in all program components. The program originated in 1995 in the Student Development Office at NCSU, where some earlier participant data resides.

The *Peer Mentor Program* offered by the African-American Student Affairs Office (TURNER, 1998) began in the fall of 1982 as a reorganization of a 1980 program in which African-American students were assigned to African-American faculty or staff members serving as volunteer mentors. In the early years, the program was small, but now serves well over half the African-American student population at NC State. Longitudinal data are available on program participants and mentors.

The Advocates for Minority Engineering Student Success (Ames ^{2}) (MITCHELL, 1998) offer a wide variety of programs through the Minority Engineering Programs office. *The Summer Transition Program (STP)* is a residential, five-week program with academic coursework as well as special skills workshops. The comprehensive description of the program's schedule found in each year's closing reports will help to quantify its components, which include study skills training, tutoring, study halls, social activities, and other activities. *START* , a peer mentoring program that is an offshoot of STP, connects junior and senior students to entering freshmen, most (but not all) of whom were participants in STP. The START program was introduced in Fall 1996 and includes explicit success skills training. Data on STP and START participants are available. Information regarding other AMES^2 programs, including clustering, supplemental instruction, counseling, early intervention, a freshman orientation course, scholarships, and professional development are still being investigated.

Women Engineers Networking Together (W.E.N.T.) (BOTTOMLEY, 1998) is a peer mentoring program that started in Fall 1998 and is run by the Women in Engineering Program and the Society of Women Engineers student chapter at NC State. The mentors and mentees meet at least once per week in some fashion, at least once per month face-to-face, and get together with all the other mentor/mentee at a larger function at least twice per semester. The approximately 140 mentor/mentee pairs are expected to maintain their relationship for one year. The Women in Engineering Program also offers an engineering sorority, various seminars and workshops, and a first-year weekend retreat for women engineering students.

7 Student Program Component Classification

Information about the structure of each student program will be kept in a separate database that can be merged with the student records of the SUCCEED longitudinal database on the basis of a program identifier. A number of important factors have been identified, indicating a fairly complicated data structure:

- The time per week spent on the program component
- The incentive for attending the program component
- The group size that characterizes the program component
- Any selection bias for participation
- The time in a student's course of study the program occurs
- The relationship of the individuals conducting the program to the student
- The nature of the program (academic, social, etc.)
- Whether the program is residential

Using this scheme, individual programs will be classified. Comprehensive programs will be broken down and their components analyzed separately—for example, the Renewed Commitment Program at NC State discussed earlier has multiple components in which each student in the program participates. In this case, the same program identifier will be used to label each of the components. In this way, when the program records are merged with the student records, a student participating in such a comprehensive program will be identified as participating in each of its components.

8 Data Analysis Strategy

When a single program is analyzed to determine its efficacy, there are many confounding factors. A common one is

that a particularly gifted faculty member or program coordinator can produce results that cannot be duplicated by others who follow the same model. Another common problem is that selection biases can skew results because the control group is not truly comparable to the experimental group. This study is designed to minimize these two effects. Analyzing similar programs at multiple institutions given under different conditions by different program administrators eliminates the program coordinator effect. If any conclusions are borne out in this analysis, they may be less striking than the results indicated by the gifted coordinator, but the trends should be more robust.

In the case of selection bias, matched-pair analysis, in which students in the control group and the experimental group are identified with values of certain independent variables that are substantially the same. This technique eliminates the variance of those independent variables in order to focus on the contributions of the variables under study (BORG and GALL, 1989, p. 678). Another way in which a large number of independent variables can be reduced to a smaller number of factors is through factor analysis (BORG and GALL, 1989, p. 620). This technique can show how each of the program factors (the ways the programs are classified) contributes to student success.

9 Conclusions

If various program components such as hours spent with a peer mentor and hours spent on academic tutoring can be classified as to their impact on student success, a major contribution to the best practices in engineering education, and higher education in general, will be achieved. For example, if the study were to show that two different approaches contributed to successful graduation in the same way, then schools could choose between them to achieve the same effect. It is easy to suggest that such a choice would be made based on cost. We suspect, however, that other institutional objectives may also guide such a choice.

This work is just beginning. This paper addresses the classification of programs into a smaller number of independent variables that will allow student programs to be broken down and their components analyzed separately. The approach to data collection and the statistical methods that will be used to quantify the relative benefit of different types of programs has also been discussed. The presentation of this paper will be highly interactive, as feedback from those attending the session is desired to affect the course of the study at this early stage.

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